DEPARTMENT OF THE AIR FORCE
59TH MEDICAL WING (AETC)
JOINT BASE SAN ANTONIO - LACKLAND TEXAS

2 FEB 2017

MEMORANDUM FOR SGVT
ATTN: LT COL NATHAN CECAVA

FROM: 59 MDW/SGVU

SUBJECT: Professional Presentation Approval

1. Your paper, entitled **Biceps Tenodesis for the Radiologist: Understand the Surgery, Fine the Complicaitons** presented at/published to **Electronic Powerpoint Poster: 2017 American Roentgen Ray Society Meeting, New Orleans, LA, 30 Apr – 5 May 2017** in accordance with MDWI 41-108, has been approved and assigned local file #**17030.**

2. Pertinent biographic information (name of author(s), title, etc.) has been entered into our computer file. Please advise us (by phone or mail) that your presentation was given. At that time, we will need the date (month, day and year) along with the location of your presentation. It is important to update this information so that we can provide quality support for you, your department, and the Medical Center commander. This information is used to document the scholarly activities of our professional staff and students, which is an essential component of Wilford Hall Ambulatory Surgical Center (WHASC) internship and residency programs.

3. Please know that if you are a Graduate Health Sciences Education student and your department has told you they cannot fund your publication, the 59th Clinical Research Division may pay for your basic journal publishing charges (to include costs for tables and black and white photos). We cannot pay for reprints. If you are 59 MDW staff member, we can forward your request for funds to the designated wing POC.

4. Congratulations, and thank you for your efforts and time. Your contributions are vital to the medical mission. We look forward to assisting you in your future publication/presentation efforts.

Linda Steel-Goodwin

LINDA STEEL-GOODWIN, Col, USAF, BSC
Director, Clinical Investigations & Research Support

PROCESSING OF PROFESSIONAL MEDICAL RESEARCH/TECHNICAL PUBLICATIONS/PRESENTATIONS

INSTRUCTIONS

USE ONLY THE MOST CURRENT 59 MDW FORM 3039 LOCATED ON AF E-PUBLISHING

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   b. In Section 2, there may be funding available for journal costs, if your department is not paying for figures, tables or photographs for your publication. Please state "YES" or "NO" in Section 2 of the form, if you need publication funding support.

2. Print your name, rank/grade, sign and date the form in the author's signature block or use an electronic signature.

3. Attach a copy of the 59 MDW IRB or IACUC approval letter for the research related study. If this is a technical publication/presentation, state the type (e.g. case report, QA/QI study, program evaluation study, informational report/briefing, etc.) in the "Protocol Title" box.

4. Attach a copy of your abstract, paper, poster and other supporting documentation.

5. Save and forward, via email, the processing form and all supporting documentation to your unit commander, program director or immediate supervisor for review/approval.

6. On page 2, have either your unit commander, program director or immediate supervisor:
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7. Submit your completed form and all supporting documentation to the CRD for processing (59crdpubspres@us.af.mil). **This should be accomplished no later than 30 days before final clearance is required to publish/present your materials.** If you have any questions or concerns, please contact the 59 CRD/Publications and Presentations Section at 292-7141 for assistance.

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    For presentations before professional societies and like organizations, the 59 MDW Public Affairs Office (PAO) will provide the needed review to ensure proper disclaimers are included and the subject matter of the presentation does not create any cause for DoD concern.

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NOTE: All abstracts, papers, posters, etc., should contain the following disclaimer statement:
"The views expressed are those of the [author(s)] [presenter(s)] and do not reflect the official views or policy of the Department of Defense or its Components"

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PROCESSING OF PROFESSIONAL MEDICAL RESEARCH/TECHNICAL PUBLICATIONS/PRESENTATIONS

1. TO: CLINICAL RESEARCH	2. FROM: (Author's Name, Rank, Grade, Office Symbol)	3. GME/GHSE STUDENT:	4. PROTOCOL NUMBER:
	NATHAN CECAVA, Lt Col, O-5, SGVT	☒ YES ☐ NO	NA

5. PROTOCOL TITLE: (**NOTE:** For each new release of medical research or technical information as a publication/presentation, a new 59 MDW Form 3039 must be submitted for review and approval.)

Biceps Tenodesis for the Radiologist: Understand the surgery, find the complications

6. TITLE OF MATERIAL TO BE PUBLISHED OR PRESENTED:

Biceps Tenodesis for the Radiologist: Understand the surgery, find the complications

7. FUNDING RECEIVED FOR THIS STUDY? ☐ YES ☒ NO FUNDING SOURCE:

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☐ 11a. PUBLICATION/JOURNAL (List intended publication/journal.)

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☒ 11c. POSTER (To be demonstrated at meeting: name of meeting, city, state, and date of meeting.)
Electronic Powerpoint Poster: 2017 American Roentgen Ray Society Meeting, New Orleans, LA; 30 Apr-5 May 2017

☐ 11d. PLATFORM PRESENTATION (At civilian institutions: name of meeting, state, and date of meting.)

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DATE	
20 Jan 2016	

14. 59 MDW PRIMARY POINT OF CONTACT (Last Name, First Name, M.I., email)	15. DUTY PHONE/PAGER NUMBER
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16. AUTHORSHIP AND CO-AUTHOR(S) List in the order they will appear in the manuscript.

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17. IS A 502 ISG/JAC ETHICS REVIEW REQUIRED (JER DOD 5500.07-R)? ☐ YES ☒ NO

I CERTIFY ANY HUMAN OR ANIMAL RESEARCH RELATED STUDIES WERE APPROVED AND PERFORMED IN STRICT ACCORDANCE WITH 32 CFR 219, AFMAN 40-401_IP, AND 59 MDWI 41-108. I HAVE READ THE FINAL VERSION OF THE ATTACHED MATERIAL AND CERTIFY THAT IT IS AN ACCURATE MANUSCRIPT FOR PUBLICATION AND/OR PRESENTATION.

18. AUTHOR'S PRINTED NAME, RANK, GRADE	19. AUTHOR'S SIGNATURE	20. DATE
NATHAN CECAVA, Lt Col, O-5	CECAVA.NATHAN.D.1183976822	December 16, 2016
21. APPROVING AUTHORITY'S PRINTED NAME, RANK, TITLE	22. APPROVING AUTHORITY'S SIGNATURE	23. DATE
MICHAEL TALL, Col, Program Director	TALL.MICHAEL.A.1035929360	January 10, 2017

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26. DATE REVIEWED 12 Jan 2017		27. DATE FORWARDED TO 502 ISG/JAC

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The abstract is approved.

30. PRINTED NAME, RANK/GRADE, TITLE OF REVIEWER	31. REVIEWER SIGNATURE	32. DATE
Rocky Calcote, PhD, Clinical Research Administrator	CALCOTE.ROCKY.D.1178245844 Digitally signed by CALCOTE.ROCKY.D.1178245844 Date: 2017.01.12 13:49:17 -06'00'	

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January 24, 2017	January 25, 2017

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Biceps Tenodesis: Understanding the surgical anatomy and identifying what can go wrong
[2949 characters with space. Maximum = 3100 characters]
Cecava ND, Bui-Mansfield LT

Background Information/Purpose [206 characters with space]

The purpose of this education exhibit is to review indications and surgical technique for biceps tenodesis and report various types of complications radiologists may encounter during post-operative imaging.

Educational Goals/Teaching Points [416 characters with space]

1. Understand the long head of biceps tendon pre-surgical anatomy and post-surgical tenodesis anatomy.
2. Understand surgical indications and techniques for biceps tenodesis.
3. Understand the role of different imaging techniques to optimally evaluate the tenodesis, associated surgical devices and surrounding structures.
4. Recognize various complications of biceps tenodesis and understand the clinical implications.

Key anatomic or pathophysiologic issues, imaging findings or imaging technique [2105 characters with space]

The anatomy of the long head of biceps tendon predisposes it to frequent injury and the tendon is a common source of shoulder pain. Injury at the tendon origin can be associated with labral injuries. The intra-articular segment at the rotator interval is highly mobile and therefore susceptible to acute or chronic trauma in conjunction with biceps pulley injuries. The tendon is subject to injury at the bicipital groove with subscapularis tendon or transverse ligament injuries. The tendon can also be injured distal to the bicipital groove. Indications for biceps tenodesis include long head biceps tendon pain, inflammation, tear or instability.

There are various surgical techniques for biceps tenodesis. Common techniques include open, arthroscopic and combined techniques with the surgeon choosing between suprapectoral and subpectoral tenodesis sites. Tenodesis methods include bone tunnel, keyhole, sutural anchor, cortical button, interference screw and soft tissue tenodesis. Operative positioning with external shoulder rotation is used to move the musculocutaneous nerve away from the subpectoral tenodesis site.

Imaging evaluation of a tenodesis site often begins with radiography to assess the osseous tenodesis site and radiodense anchor devices if present. MRI is often employed for advanced imaging of suspected tenodesis failure or for radiographic findings of pseudo mass at the tenodesis site. Sonography and CT have a limited role, mainly for problem solving.

Potential complications of biceps tenodesis include humeral fracture, failure of the tenodesis anchoring device, partial/complete tear of the biceps tendon, or inadequate bicep tendon tension. Iatrogenic nerve damage can involve the brachial plexus, suprascapular, musculocutaneous, radial or median nerves. Other complications include infection, hematoma, seroma formations, pseudotumors, and persistent pain. Poor clinical outcomes include decreased biceps function and strength, a biceps "Popeye" cosmetic deformity, and pain from mechanical, inflammatory or neuropathic pain including complex regional pain syndrome.

Conclusion [222 characters with space]

Biceps tenodesis is a frequently performed procedure. Radiologists must understand the pre-surgical and post-surgical anatomy of the long head of biceps tendon and be ready to recognize the complications of this procedure.

Maximum number of slides: 5
Include no more than 2 images
Abstract title is at the top of the first slide
Animation and/or video is not allowed

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Biceps Tenodesis for the Radiologist: Understand the surgery, find the complications

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Disclosure Statements

- The authors received no financial support or incentive in the creation of this educational exhibit.

- The view(s) expressed herein are those of the authors and do not reflect the official policy or positions of Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Army, the Department of the Air Force, the Department of Defense, or the U.S. Government.

Educational Goals

1. Understand the anatomy of long head biceps (LHB) tendon before and after surgical tenodesis.
2. Understand surgical indications and techniques for biceps tenodesis.
3. Understand the role of various imaging modalities in the evaluation of biceps tenodesis.
4. Be able to recognize complications of biceps tenodesis and understand the clinical implications.

Target Audience: Radiologists and Orthopedic Surgeons

LHB Tendon Anatomy

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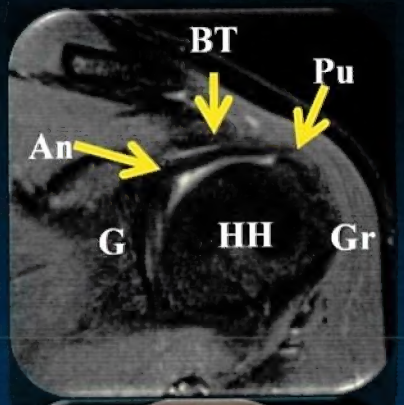
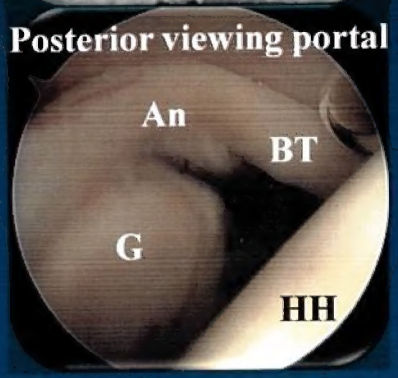


Posterior viewing portal

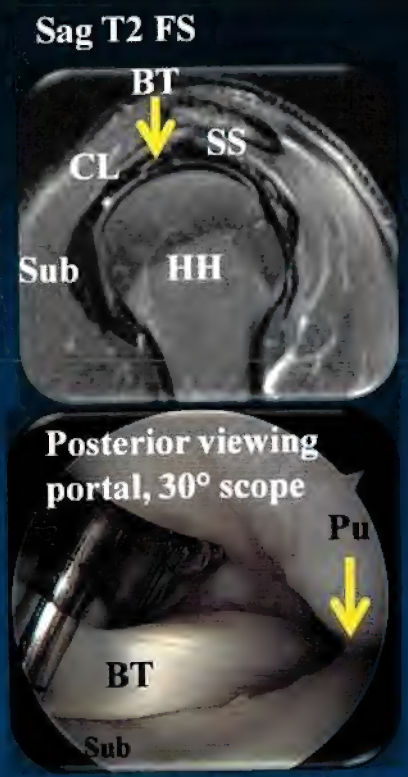


Biceps Tendon (BT)
Humeral Head (HH)
Glenoid (G)
Biceps Anchor (An)
Biceps Pulley (Pu)
Bicipital Groove (Gr)

- Biceps Tendon:
  - 5-6 mm in diameter, 9 cm in length
  - Slides up to 18 mm in glenohumeral joint
  - Intraarticular portion extends from glenoid anchor to bicipital groove
  - Tenosynovitis, detachment, and tearing result from mechanical forces (torsional forces, longitudinal traction, impingement, biceps pulley dysfunction)
- Biceps Anchor
  - Attaches at superior glenoid tubercle

Elser F, et al. Arthroscopy 2011;27(4):581-92

LHB Tendon Anatomy



Biceps Tendon (BT)
Humeral Head (HH)
Supraspinatus Tendon (SS)
Subscapularis Tendon (Sub)
Coracohumeral Ligament (CL)
Biceps Pulley (Pu)

- Biceps Pulley: coracohumeral ligament, superior glenohumeral ligament and subscapularis tendon
- Rotator Interval
  - Contains intra-articular LHB tendon
  - Located between *supraspinatus* and *subscapularis* tendons
  - Bounded superficially by *coracohumeral ligament*
  - Bounded deep by *superior glenohumeral ligament*

Petchprapa CN, et al. AJR 2010;195(3):567-76

Bicipital Groove

Biceps Tendon (BT)
Humeral Head (HH)
Subscapularis Tendon (Sub)
Lesser Tuberosity (LT)
Greater Tuberosity (GT)
Biceps Pulley (Pu)
Bicipital Groove (BG)

- Formed by humeral lesser tuberosity, greater tuberosity, and transverse ligament
- Contains synovium
- Usually in communication with glenohumeral joint

History of LHB Tenodesis

- In 1926, Gilcreest EL, first described tenodesing a ruptured LHB tendon to the coracoid process
- In the 1980's, orthopedic surgeons noted that shoulder pain was often relieved by rupture of the LHB tendon, and began developing *tenotomy* and *tenodesis* strategies

Voss A, et al. Clin Sports Med 2016;35(1):137-52

LHB Tenodesis
Surgical Indications

1. LHB tendonitis and tear (partial or complete) which fail conservative therapy
2. Tendon pathology may be located at the following locations:
   a) Anchor (superior labrum anterior posterior tear)
   b) Intraarticular segment
   c) Bicipital groove (friction at groove synovium can be a source of pain)
3. LHB tendon instability due to subscapularis tendon tear or pulley injury
4. Physically active patients younger than 60-years-old

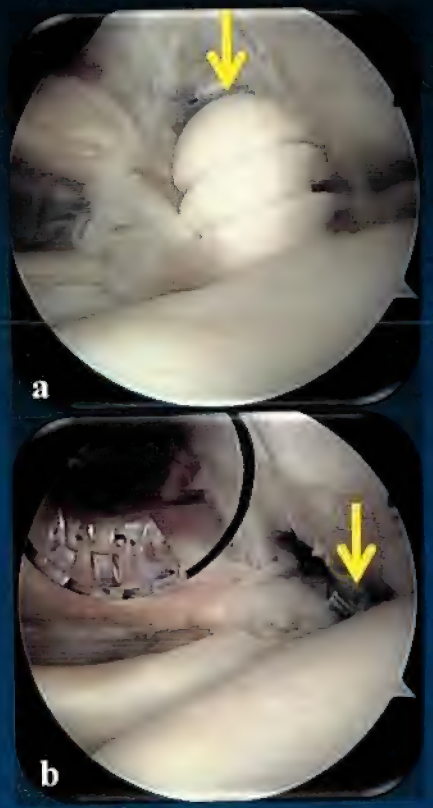
Voss A, et al. Clin Sports Med 2016;35(1):137-52
Abraham VT, et al. Arthroscopy 2016;32(2):365-71

Tenodesis vs Tenotomy

Tenodesis	Tenotomy
Performed in patients **< 60-years-old**	Performed in patients **> 60-years-old**
Longer recovery time	**Shorter** recovery time
LHB tenodesis in groove (suprapectoral technique) **or** evacuated from groove (subpectoral technique)	Biceps tendon evacuated from groove
Arm flexion power and range of motion maintained	Most flexion power maintained by biceps short head; **possible partial loss of flexion range of motion**
Arm supination power maintained	A portion of **supination power lost**
LHB tendon tension maintained	**Popeye** deformity

Virk MS, et al. Clin Sports Med 2016;35(1):181-8

LHB Tenodesis Surgery:
Suprapectoral Intraarticular Method



- Procedure performed entirely *arthroscopically* and *intraarticularly* in glenohumeral joint
- LHB tenotomy at the anchor
- LHB tendon stump trimmed
  - Superior labrum anterior posterior tear if present can be repaired with suture anchor or debrided
- Intraarticular fixation in proximal bicipital groove
- LHB tendon fixation completed with interference screw or suture anchor

Shoulder arthroscopic images from posterior portal show suprapectoral LHB tenodesis with placement of 7 x 23 biocomposite screw. (a) Interference screw (arrow) placement in upper bicipital groove. (b) After screw is drilled flush, suture ends (arrow) are secured.

LHB Tenodesis Surgery
Subpectoral Method

- Uses **combined** arthroscopic and open approach
- Arthroscopic portion
  - LHB tenotomy at anchor
- Open portion
  - Incision at axillary fold, over superior humeral diaphysis, distal to pectoral attachment
  - Intra-articular LHB tendon delivered distally through incision
  - Tendon cut to tension length and prepared with suture anchors
  - Humeral cortex drilled
  - Various choices for tenodesis method

Subpectoral Tenodesis
Fixation Methods

- Bone tunnel
- Keyhole
- Suture anchor
- Cortical button
- Interference screw
- Soft tissue tenodesis
  - Rotator interval (suprapectoral)
  - Conjoined tendon (subpectoral)

Subpectoral Tenodesis Types: Bone Tunnel

- 2 or 3 anterior humeral cortical holes drilled
- 2 holes:
  - Tendon passed into *distal* hole, out *proximal* hole, and tendon stump sutured to *pectoralis*
- 3 holes:
  - Tendon passed into a *central* hole and sutures passed out of smaller *proximal* and *distal* cortical holes and tied

Voss A, et al. Clin Sports Med 2016;35(1):137-52

Subpectoral Tenodesis Types: Keyhole

- Keyhole drilled into *anterior* humerus (round hole proximally with distal slit)
- LHB tendon stump rolled into ball and sutured to maintain shape
- Tendon ball passed through the round portion of the keyhole and tendon pulled distally into slit to achieve anchoring

Voss A, et al. Clin Sports Med 2016;35(1):137-52

Subpectoral Tenodesis Types: Suture Anchor

- Small anterior humeral cortical holes drilled
- Sutures attached to the LHB tendon stump passed in and out of the small holes. The suture ends are then tied to each other.
- *Disadvantage*: the biceps tendon must heal to the surface of the humeral cortex instead of an intramedullary bone tunnel

Voss A, et al. Clin Sports Med 2016;35(1):137-52

Subpectoral Tenodesis Types: Cortical Button

- Bicortical technique:
  - *Anterior* and *posterior* humeral holes drilled (8 mm diameter anterior, 3.2 mm diameter posterior)
  - Button with attached tendon sutures is passed into the anterior hole and out the posterior hole where it anchors from outside the cortex
  - Sutures are tightened to achieve tendon tension
  - Potential axillary nerve injury (nerve located 0-3 mm from posterior extra-cortical button)
- Unicortical technique:
  - Variation of above except only a 3.2 mm *anterior* humeral hole is drilled
  - Anchor button within the intramedullary space

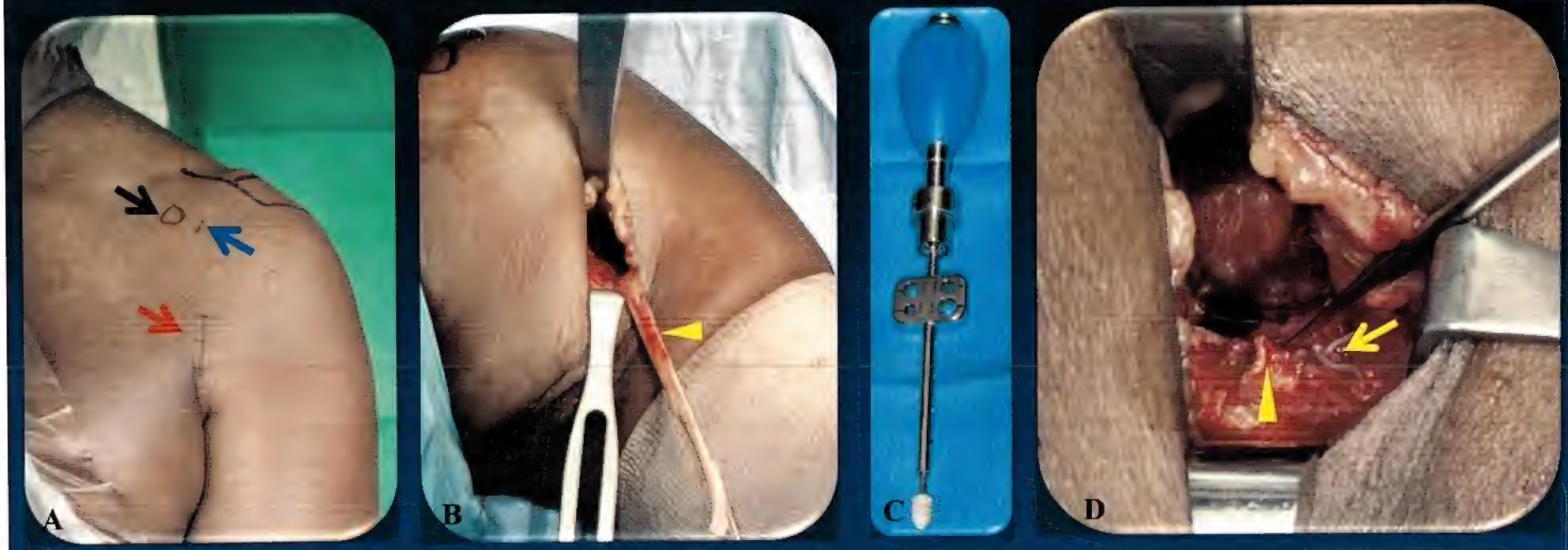
Arora AS, et al. Arthroscopy 2013;29(4):638-44

Subpectoral Tenodesis Types: Interference Screw

- 8 mm diameter anterior humeral cortical hole is drilled
- One suture from LHB tendon is loaded through the interference screw and drill
- Interference screw and tendon are drilled into humerus until screw is flush with cortex
- The two sutural ends are tied at the surface of screw and humeral cortex

Voss A, et al. Clin Sports Med 2016;35(1):137-52

Subpectoral LHB Tenodesis Surgery



Intraoperative photos of subpectoral LHB tenodesis. (A) Beach chair patient positioning. Arrows annotating skin marking of coracoid tip (black), anterior arthroscopy port (blue) and anterior axillary incision for open tenodesis (red). (B) Retracted anterior axillary incision. After arthroscopic LHB tenotomy, the LHB tendon (arrowhead) has been pulled distally and delivered through the surgical incision. (C) Interference screw and driver. (D) Image after tenodesis showing portions of the LHB tendon sutures (yellow arrow) and biceps tendon (arrowhead) at the anterior humeral tenodesis site.

Suprapectoral vs Subpectoral Tenodesis Effectiveness

- Suprapectoral (arthroscopic) vs subpectoral (open)

- Abraham VT, et al. Arthroscopy 2016;32(2):365-71
  - Systematic review article (examined data from 16 studies)
  - Found no difference in poor outcomes (2%)

Tenodesis Anchor Comparison

Cadaveric tenodesis strength studies

1. Mazzocca AD, et al. Arthroscopy 2005;21(11):1296-306
   - No difference in load to failure for open subpectoral bone tunnel, open subpectoral interference screw, arthroscopic suture anchor and arthroscopic interference screw
   - Subpectoral bone tunnel did have statistically significant increased displacement when subjected to cyclic loading (5,000 cycles)
2. Arora AS, et al. Arthroscopy 2013;29(4):638-44
   - No difference in load to failure for open subpectoral interference screw vs unicortical endobutton

Common Tenodesis Anchors

Visual and Radiograph Appearance

Arthrex 7x10 mm tenodesis screw	Mitek 8x23 mm interference screw	Mitek GII QuickAnchor Plus	Smith&Nephew Endobutton with 15 mm continuous loop suture	Smith&Nephew 17 mm fixation button

LHB Tenodesis Radiography

***Suprapectoral* interference screw: Often not visible**

***Subpectoral* interference screw: May mimic bone lesion. Distinguish by *location*, sharp *border* and *tubular lucency* extending to cortex**

Unicortical *subpectoral* cortical button: Metallic or non-metallic anchoring device in the intramedullary space next to the anterior cortex

LHB Tenodesis MRI

***Suprapectoral* interference screw: Screw tract is seen in superolateral humeral head or bicipital groove**

Interference screw

***Subpectoral* interference screw: Cortical defect (interference screw) or susceptibility artifact (metallic cortical button) below the bicipital groove**

LHB Tenodesis CT

Dislodged suprapectoral interference screw (arrow)

- Interference screw tracts have similar lucent appearance as seen on radiography
- Interference screws are sometimes faintly visible
- Metallic cortical buttons will be easily visualized

LHB Tenodesis MDP Bone Scan

- MDP Bone scan: After 6 months, a normal tenodesis site should have *no uptake* or *mild* focal increased *uptake*. Intense linear uptake is a possible indication of anchor failure.

Normal

Abnormal

LHB Tenodesis Complications

➢ **Humerus fracture**	➢ **Humeral anchor dislodgement or failure**
➢ **Biceps tendon tear**	➢ **Inadequate bicep tension**
➢ **Pseudotumor** ▪ Heterotopic ossification ▪ Infection/abscess ▪ Seroma ▪ Hematoma	➢ **Iatrogenic nerve injury** ▪ Brachial plexus ▪ Suprascapular ▪ Musculocutaneous ▪ Radial ▪ Median ▪ Axillary
➢ **Pain including complex region pain syndrome**	

Arora AS, et al. Arthroscopy 2013;29(4):638-44

Virk MS, et al. Clin Sports Med 2016;35(1):181-8

Incidence of Suprapectoral Complications

- Case series of 1,083 suprapectoral procedures
  - Revision surgery rate = 4.7%
  - Adhesive capsulitis/stiffness: 20 (1.8%)
  - Symptomatic biceps rupture: 3 (0.3%)
  - Suprascapular neuropathy: 1 (0.1%)
  - Heterotopic ossification: 2 (0.2%)
  - Persistent bicipital pain: 1 (0.1%)
- No humeral fracture was reported

Brady PC, et al. Arthroscopy 2015;31(3):470-6

Incidence of Subpectoral Complications

- Case series of 353 subpectoral interference screw procedures
  - Total complication rate = 2%
  - Failed tenodesis: 2 (0.6%)
  - Musculocutaneous neuropathy: 1 (0.3%)
  - Wound infection: 1 (0.3%)
  - Complex regional pain syndrome: 1 (0.3%)
  - Persistent bicipital pain: 2 (0.6%)
- No humeral fracture was reported

Nho ST, et al. J Shoulder Elbow Surg 2010;19(5):764-8

Post Tenodesis Humerus Fracture

- Recognized rare complication
- No published incidence rates
- Some authors believe that 8 mm drilled cortical hole (interference screw) increases risk vs 3.2 mm unicortical endobutton hole
- Typically occurs in the first few months following surgery
- Case reports of humeral fractures
  - Subpectoral interference screw: 2 cases
  - Subpectoral keyhole: 3 cases
- No case reports for *suprapectoral* tenodesis

Arora AS, et al. Arthroscopy 2013;29(4):638-44
Virk MS, et al. Clin Sports Med 2016;35(1):181-8

Subpectoral Tenodesis Complications: Humerus Fracture

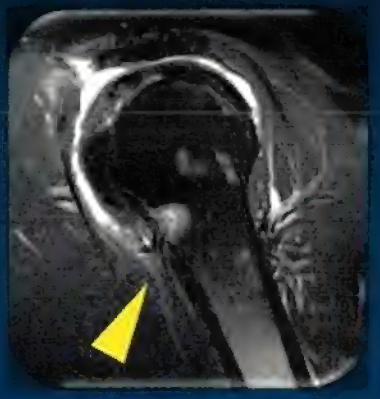
32-year-old man had subpectoral LHB tenodesis performed with Arthrex tenodesis screw for tendonitis pain. Radiographs immediately following surgery show tenodesis humeral defect (arrow). 7 months later, he sustained fracture at the tenodesis site while weightlifting. Corrective open reduction internal fixation was performed.

Suprapectoral Tenodesis Complications: Interference Screw Dislodgement

a) X-ray

b) Sag T1

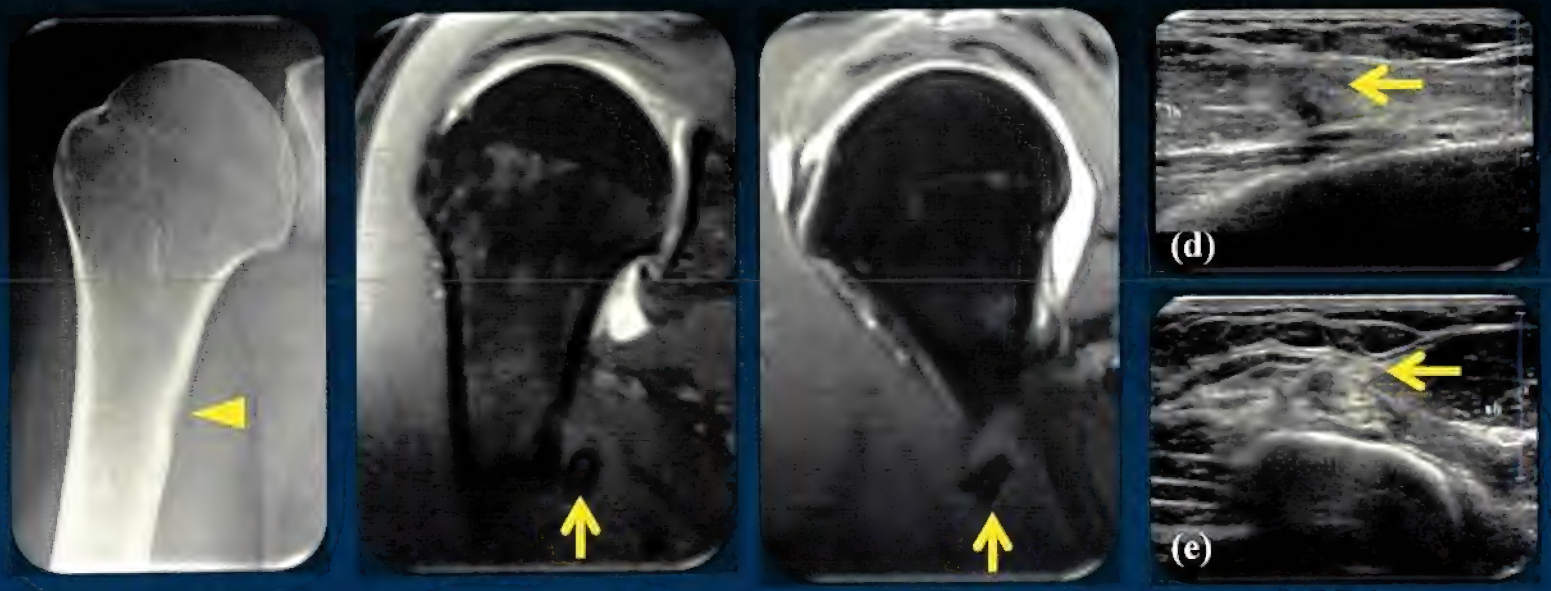
c) Ax PD FS



d) Sag T2 FS

35-year-old man had suprapectoral LHB tenodesis with SwiveLock Biocomposite tenodesis screw and persistent pain 2 months following surgery. Axillary shoulder radiograph (a) and MRI (b-d) reveal dislodged tenodesis interference screw (arrow). Image (d) demonstrates fibers from the biceps tendon still attached to the tenodesis site.

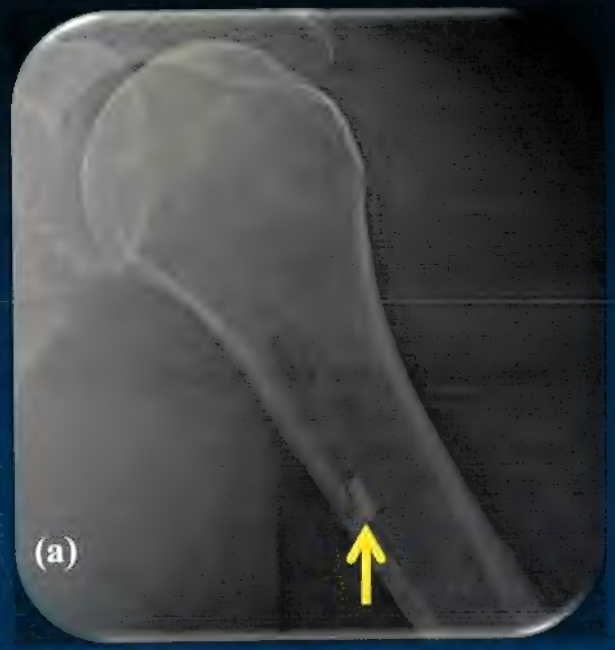
Subpectoral Tenodesis Complications: Interference Screw Dislodgement

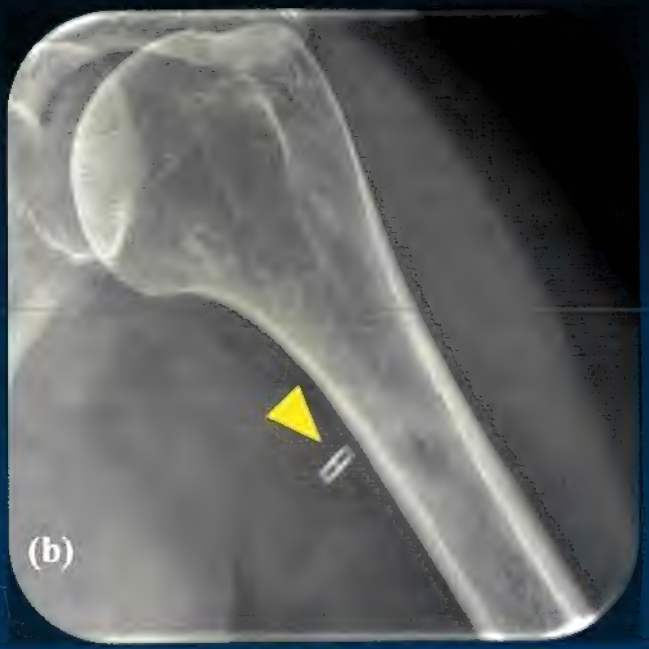


a) X-ray b) Cor T1 FS c) Sag T1 FS d) US long e) US trans

52-year-old man had subpectoral LHB tenodesis with interference screw and persistent pain 6 months following surgery. AP shoulder radiograph shows a normal tenodesis site (arrowhead). MRI (b,c) and ultrasound (d,e) reveal a dislodged tenodesis interference screw (arrow).

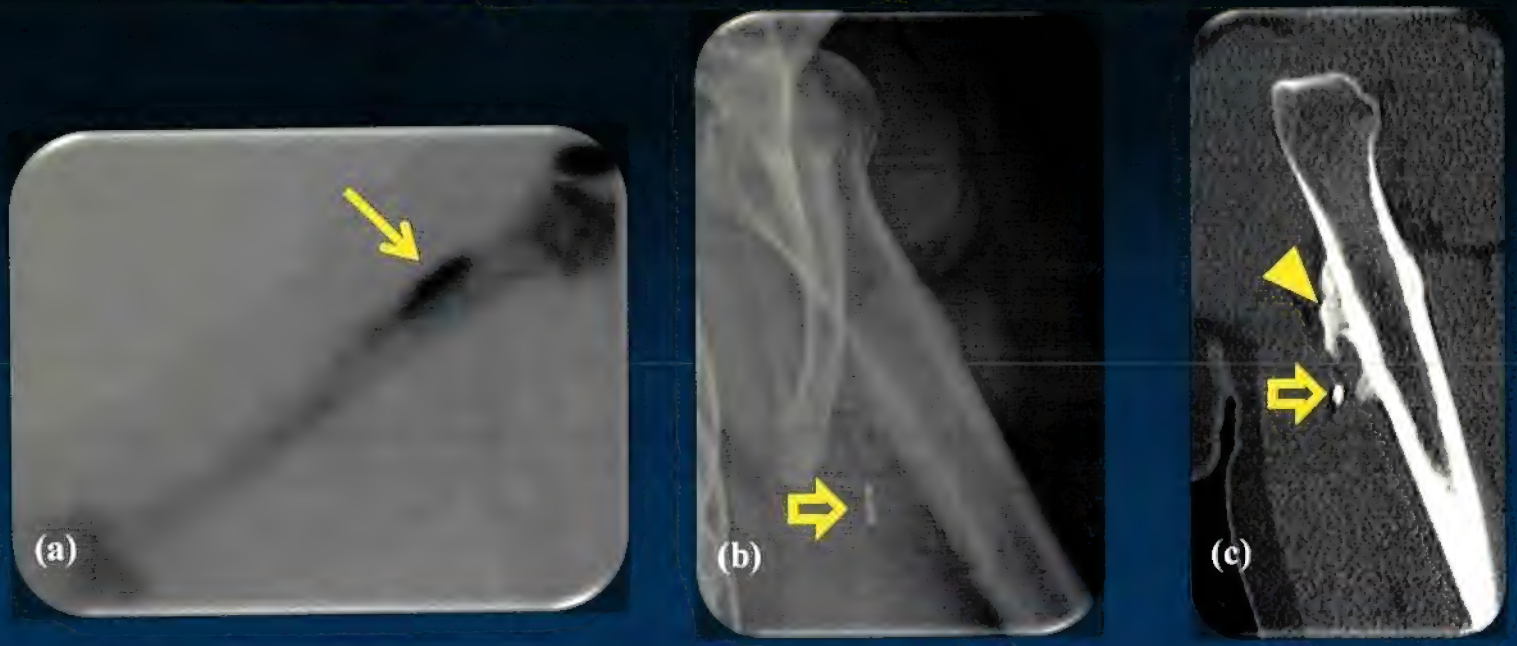
Subpectoral Tenodesis Complications: Cortical Button Dislodgement





57-year-old woman had subpectoral LHB tenodesis with unicortical metallic endobutton.
(a) Post-operative radiographs prior to trauma shows the button in expected intramedullary position (arrow) with adjacent unicortical drill hole.
(b) 17 months later, patient had a cycling accident. The button (arrowhead) has been dislodged through the anterior cortex and is external to the humerus. There should be no gap between anchor button and humerus. Also note 90 degree rotation of the button.

Subpectoral Tenodesis Complications:
Cortical Button Dislodgement and Post Operative Pseudotumor



44-year-old man 1 year following cortical button subpectoral LHB tenodesis with persistent arm pain. MDP bone scan (a) of the right humerus reveals radiotracer uptake at the tenodesis site (closed arrow) mimicking a bone lesion. Scapular Y radiograph (b) and sagittal non-contrast CT (c) of the right shoulder show extracortical inferior button displacement from the tenodesis site (open arrow) with heterotopic bone formation (arrowhead) accounting for the uptake on bone scan.

Subpectoral Tenodesis Complications: Neuropathy

- *Musculocutaneous nerve* is in close proximity to *anterior* axillary surgical bed
- *Axillary nerve* is in close proximity to *posterior* humeral cortex for bicortical techniques
- Multiple upper extremity nerves can be injured by wound retraction or surgical instruments
- Case reports of post procedure neuropathy:
  - Brachial Plexus (2 cases)
  - Musculocutaneous nerve (4 cases)
  - Median nerve (1 case)

Rhee PC, et al. Am J Sports Med 2013;41(9):2048-53

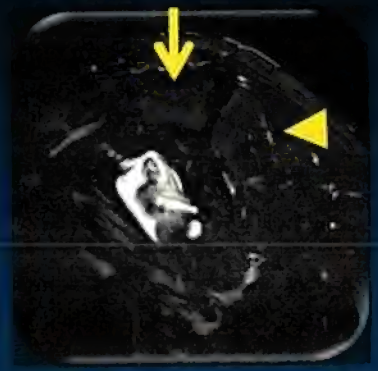
Nho ST, et al. J Shoulder Elbow Surg 2010;19(5):764-8.

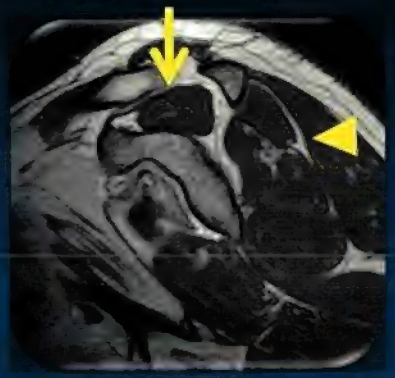
Subpectoral Tenodesis Complications: Suprascapular Nerve Injury

36-year-old man with left shoulder weakness 4 weeks after subpectoral LHB tenodesis. EMG confirmed suprascapular neuropathy.

Sagittal shoulder MR arthrogram: Acute supraspinatus (arrow) and infraspinatus (arrowhead) neurogenic myopathy with loss of bulk. Subpectoral biceps tendon anchor (open arrow).

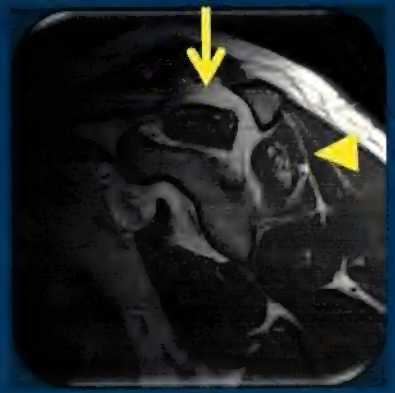
Pre-op



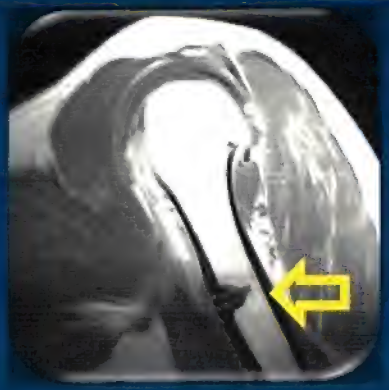


Post-op

Sag T2 FS

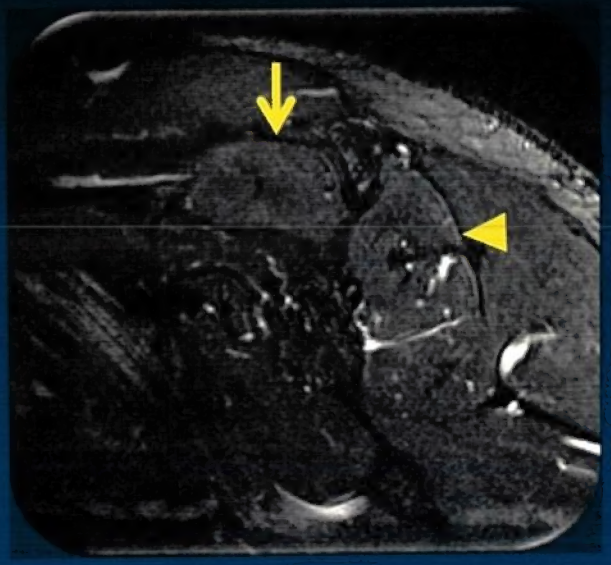


Sag T1

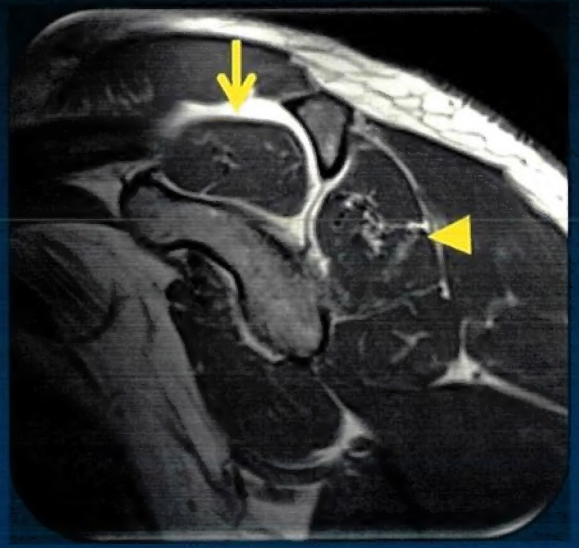


Sag T1

Subpectoral Tenodesis Complications: Suprascapular Nerve Injury



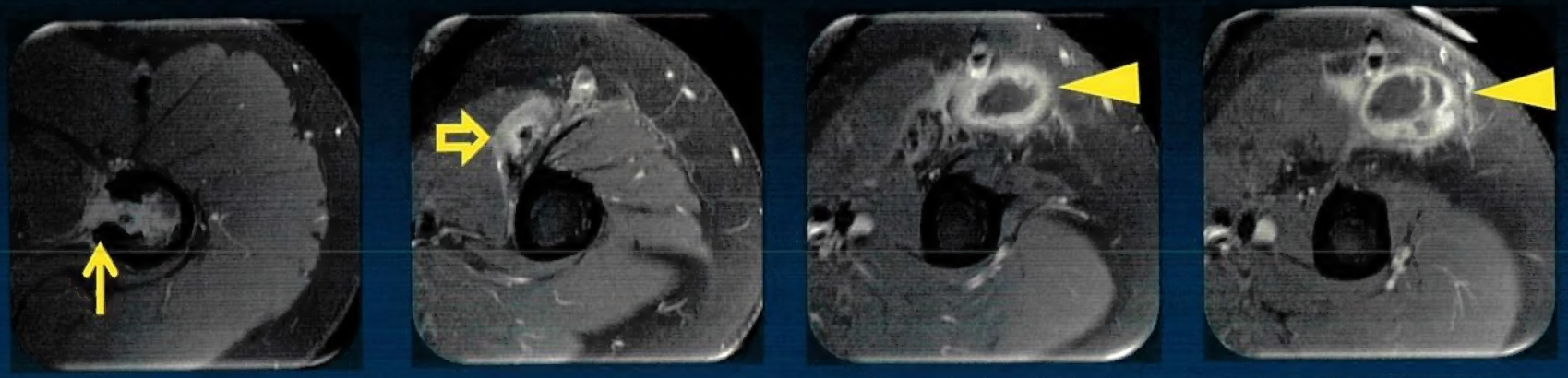
Sag T2 FS



Sag T1

Same 36-year-old man 2 years after subpectoral LHB tenodesis. Sagittal shoulder MR arthrogram: Supraspinatus (arrow) and infraspinatus (arrowhead) muscles are now normal signal and size, suggestive of suprascapular neuropathy resolution.

Subpectoral Tenodesis Complications: Post-operative Abscess



Superior Inferior

42-year-old man with palpable mass following interference screw subpectoral LHB tenodesis. Axial T1 fat suppressed gadolinium post contrast imaging of the left upper humerus months after surgery shows inflammation and partial tearing of the biceps tendon at the tenodesis site (closed arrow) extending inferiorly to the myotendinous junction (open arrow). A rim enhancing fluid collection (arrowhead) extends laterally from the myotendinous junction. At incision and drainage, this was found to be a *pseudomonas abscess*.

Summary Teaching Points

1. Post surgical LHB tenodesis appearance may mimic bone neoplasm to the inexperienced radiologists
2. LHB tenodesis complications include humerus fracture, tenodesis anchor failure, biceps tendon tear, inadequate tendon tension, post surgical seroma/infection, and iatrogenic nerve palsy
3. Understanding surgical technique is important in assessing these complications
4. Radiologists have an important role in diagnosing tenodesis complications to guide early therapy

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